What is claimed is:

1. A fuel cell, comprising:

a thin film electrolyte layer having a first surface and a second surface, the first surface being opposed to the second surface;

a thick film anode layer disposed on the first surface; and

a thick film cathode layer disposed on the second surface.

2. The fuel cell as defined in claim 1 wherein the electrolyte layer has a thickness ranging from about less than 1 micron to about 20 microns.

3. The fuel cell as defined in claim 2 wherein the electrolyte layer has a thickness of less than about 10 microns.

4. The fuel cell as defined in claim 3 wherein the electrolyte layer has a thickness ranging between about 2 microns and about 5 microns.

5. The fuel cell as defined in claim 1 wherein each of the anode and cathode layers has a thickness greater than about 30 microns.

6. The fuel cell as defined in claim 5 wherein each of the anode and cathode layers has a thickness ranging between about 30 microns and about 500 microns.

7. The fuel cell as defined in claim 1 wherein the anode layer has an interconnected porosity ranging between about 19% and about 55%; and the cathode layer has an interconnected porosity ranging between about 19% and about 55%.

8. The fuel cell as defined in claim 7 wherein each of the anode layer interconnected porosity and the cathode layer interconnected porosity ranges between about 20% and about 25%.

9. The fuel cell as defined in claim 1 wherein the electrolyte layer comprises a material selected from the group consisting of yttria stabilized zirconia, samaria doped ceria, partially stabilized zirconia, stabilized bismuthsesquioxide (Bi_2O_3), tantalum pentoxide (Ta_2O_5), and lanthanum strontium gallium magnesium oxide.

10. The fuel cell as defined in claim 9 wherein the electrolyte layer consists essentially of Ta_2O_5.

11. The fuel cell as defined in claim 9 wherein the electrolyte layer consists essentially of lanthanum strontium gallium magnesium oxide.

12. The fuel cell as defined in claim 1 wherein the anode layer comprises a material selected from the group consisting of nickel (Ni), Ni-yttria stabilized zirconia cermet, copper doped ceria, gadolinium doped ceria, strontium doped ceria, yttria doped ceria, Cu-YSZ cermet, Co-stabilized zirconia cermet, Ru-stabilized zirconia cermet, LSGM + nickel oxide, and mixtures thereof.

13. The fuel cell as defined in claim 1 wherein the cathode layer comprises a material having a perovskite structure.

14. The fuel cell as defined in claim 13 wherein the cathode layer comprises a material selected from the group consisting of lanthanum strontium manganate, lanthanum strontium ferrite, lanthanum strontium cobaltite, $LaFeO_3/LaCoO_3$, $YMnO_3$, $CaMnO_3$, $YFeO_3$, and mixtures thereof.

15. The fuel cell as defined in claim 1 wherein the cathode layer comprises silver.

16. The fuel cell as defined in claim 1, the fuel cell further comprising:

a first interfacial layer, positioned between the anode and the electrolyte; and

a second interfacial layer positioned between the cathode and the electrolyte.

17. The fuel cell as defined in claim 16 wherein the first interfacial layer comprises yttria doped ceria (YDC).

18. The fuel cell as defined in claim 16 wherein the second interfacial layer comprises yttria stabilized bismuthsesquioxide (YSB).

19. The fuel cell as defined in claim 1, further comprising a material for connecting the fuel cell to at least one of an electrical load and an electrical storage device, the connecting material deposited on at least one of the anode layer and the cathode layer.

20. The fuel cell as defined in claim 19 wherein the electrical load comprises at least one of computers, portable electronic appliances, and communication devices.

21. The fuel cell as defined in claim 19 wherein the electrical storage device comprises at least one of capacitors, batteries, and power conditioning devices.

22. The fuel cell as defined in claim 19 wherein the connecting material has as a main component thereof a material selected from the group consisting of silver, palladium, platinum, gold, titanium, tantalum, chromium, iron, nickel, carbon, stainless steels, high temperature nickel alloys, tungsten, and mixtures thereof.

23. The fuel cell as defined in claim 1, further comprising a material for interconnecting at least two of the fuel cells, the interconnecting material deposited on at least one of the anode layer and the cathode layer.

24. The fuel cell as defined in claim 23 wherein the interconnecting material is a material selected from the group consisting of lanthanum chromites, nickel, copper, titanium, tantalum, chromium, iron, carbon, stainless steels, high temperature nickel alloys, tungsten, and mixtures thereof.

25. The fuel cell as defined in claim 1, further comprising:
a plurality of the fuel cells arrayed within a substrate;
an electrical connection between the plurality of anode layers; and
an electrical connection between the plurality of cathode layers.

26. The fuel cell as defined in claim 25 wherein the plurality of fuel cells are connected within a planar array, the planar array having a first plane adapted to contact a source of oxygen, the first plane having a plurality of cathode layers therein, the planar array further having a second plane opposed to the first plane, the second plane adapted to contact a fuel, the second plane having a plurality of anode layers therein.

27. The fuel cell as defined in claim 26 wherein the source of oxygen is air.

28. The fuel cell as defined in claim 26 wherein the fuel is selected from the group consisting of methane, butane, propane, pentane, methanol, ethanol, higher straight chain or mixed hydrocarbons, and mixtures thereof.

29. The fuel cell as defined in claim 1 wherein the fuel cell has a power density of between about 100 mW/cm^2 and about 2000 mW/cm^2.

30. The fuel cell as defined in claim 29 wherein the fuel cell has a power density of between about 1000 mW/cm^2 and about 2000 mW/cm^2.

31. The fuel cell as defined in claim 30 wherein the fuel cell has an operating temperature of between about 400°C and about 800°C.

32. The fuel cell as defined in claim 31 wherein the fuel cell has an operating temperature of between about 400°C and about 600°C.

33. The fuel cell as defined in claim 32 wherein the fuel cell has an operating temperature of between about 400°C and about 500°C.

34. A fuel cell, comprising:

a thin film electrolyte layer having a first surface and a second surface, the first surface being opposed to the second surface, wherein the electrolyte layer has a thickness of less than about 10 microns;

a thick film anode layer disposed on the first surface, wherein the anode layer has an interconnected porosity ranging between about 19% and about 55%; and

a thick film cathode layer disposed on the second surface, wherein the cathode layer has an interconnected porosity ranging between about 19% and about 55%, and wherein each of the anode and cathode layers has a thickness greater than about 30 microns.

35. The fuel cell as defined in claim 34 wherein each of the anode layer, cathode layer and electrolyte layer are formed substantially within a substrate.

36. The fuel cell as defined in claim 35 wherein the electrolyte layer comprises a material selected from the group consisting of yttria stabilized zirconia, samaria doped ceria, partially stabilized zirconia, stabilized bismuthsesquioxide (Bi_2O_3), tantalum pentoxide (Ta_2O_5), and lanthanum

strontium gallium magnesium oxide; wherein the anode layer comprises a material selected from the group consisting of nickel (Ni), Ni-yttria stabilized zirconia cermet, copper doped ceria, gadolinium doped ceria, strontium doped ceria, yttria doped ceria, Cu-YSZ cermet, Co-stabilized zirconia cermet, Ru-stabilized zirconia cermet, LSGM + nickel oxide, and mixtures thereof; and wherein the cathode layer comprises a material selected from the group consisting of lanthanum strontium manganate, lanthanum strontium ferrite, lanthanum strontium cobaltite, $LaFeO_3/LaCoO_3$, $YMnO_3$, $CaMnO_3$, $YFeO_3$, silver, and mixtures thereof.

37. The fuel cell as defined in claim 35, the fuel cell further comprising:

a first inter-facial layer, positioned between the anode and the electrolyte; and

a second interfacial layer positioned between the cathode and the electrolyte.

38. The fuel cell as defined in claim 37, further comprising a material for connecting the fuel cell to at least one of an electrical load and an electrical storage device, the connecting material deposited on at least one of the anode layer and the cathode layer, wherein the electrical load comprises at least one of computers, portable electronic appliances, and communication devices, and wherein the electrical storage device comprises at least one of capacitors, batteries, and power conditioning devices.

39. The fuel cell as defined in claim 38, further comprising a material for interconnecting at least two of the fuel cells, the interconnecting material deposited on at least one of the anode layer and the cathode layer.

40. The fuel cell as defined in claim 39, further comprising:
a plurality of the fuel cells arrayed within a substrate;
an electrical connection between the plurality of anode layers; and
an electrical connection between the plurality of cathode layers.

41. The fuel cell as defined in claim 40 wherein the plurality of fuel cells are connected within a planar array, the planar array having a first plane adapted to contact a source of oxygen, the first plane having a plurality of cathode layers therein, the planar array further having a second plane opposed to the first plane, the second plane adapted to contact a fuel, the second plane having a plurality of anode layers.

42. A method of making a fuel cell, the method comprising the steps of:

creating a well in a dielectric or semiconductor substrate, the substrate having a first side and a second side, the second side opposed to the first side, and the well being defined in the first side;

depositing a thin film solid oxide electrolyte layer on the surface of the well;

applying an electrode layer in the electrolyte coated well;

creating a counter well in the second side, the counter well abutting the electrolyte layer; and

applying a counter electrode layer in the counter well.

43. The method as defined in claim 42 wherein the step of depositing the electrolyte layer is performed by at least one of sputter deposition and chemical vapor deposition (CVD).

44. The method as defined in claim 42, further comprising the step of firing the electrolyte layer prior to application of the electrode layer.

45. The method as defined in claim 42, further comprising the step of applying an isolation dielectric on the second side of the substrate.

46. The method as defined in claim 42 wherein the substrate is silicon, and wherein the isolation dielectric is grown on the second side of the substrate.

47. The method as defined in claim 42, further comprising the step of processing the electrode layer and the counter electrode layer using planarization techniques.

48. The method as defined in claim 42 wherein the planarization is performed by at least one of chemical mechanical polishing (CMP) and mechanical polishing.

49. The method as defined in claim 42, further comprising the step of applying a hard mask to the first side of the substrate before the step of creating a well.

50. The method as defined in claim 49 wherein the substrate is silicon, and wherein the first side hard mask is grown on the substrate first side.

51. The method as defined in claim 42, further comprising the step of applying a hard mask to the second side of the substrate before the step of creating a counter well.

52. The method as defined in claim 51 wherein the substrate is silicon, and wherein the second side hard mask is grown on the substrate second side.

53. The method as defined in claim 42 wherein the step of creating the well and the step of creating the counter well are each carried out by etching.

54. The method as defined in claim 42 wherein the substrate is silicon, and wherein the etching is performed by an etchant selected from the group consisting of wet anisotropic etchants, plasma anisotropic etchants, and mixtures thereof, thereby forming ultra-smooth surfaces on the well and the counter well.

55. The method as defined in claim 54 wherein the wet anisotropic etchants are selected from the group consisting of potassium hydroxide (KOH), tetramethyl ammonium hydroxide (TMAH), a mixture of potassium hydroxide and isopropyl alcohol, ammonium hydroxide, sodium hydroxide, cerium hydroxide, ethylene diamine pyrocatechol, and mixtures thereof.

56. The method as defined in claim 54 wherein the plasma anisotropic etchant is sulfur hexafluoride alternated with C_4F_8.

57. The method as defined in claim 42 wherein the substrate is a silicon oxide containing dielectric substrate, and wherein the etching is performed by a hydrofluoric containing isotropic etchant.

58. The method as defined in claim 42 wherein the substrate is selected from the group consisting of single crystalline silicon, polycrystalline silicon, silicon oxide containing dielectric substrates, alumina, sapphire, ceramic, and mixtures thereof.

59. The method as defined in claim 58 wherein the substrate is single crystalline silicon.

60. The method as defined in claim 42 wherein at least one of the well and the counter well is adapted to contain a thick film electrode layer.

61. The method as defined in claim 60 wherein the well contains a thick film electrode and the counter well contains a thick film counter electrode.

62. A method of making a fuel cell, the method comprising the steps of:

creating a well in a dielectric or semiconductor substrate, the substrate having a first side and a second side, the second side opposed to the first side, and the well being defined in the first side;

depositing a thin film solid oxide electrolyte layer on the surface of the well, wherein the step of depositing the electrolyte layer is performed by at least one of sputter deposition and chemical vapor deposition (CVD);

applying an electrode layer in the electrolyte coated well;

creating a counter well in the second side, the counter well abutting the electrolyte layer, wherein the step of creating the well and the step of creating the counter well are each carried out by etching;

applying an isolation dielectric on the second side of the substrate;

applying a counter electrode layer in the counter well; and

processing the electrode layer and the counter electrode layer using planarization techniques, wherein the planarization is performed by at least one of chemical mechanical polishing (CMP) and mechanical polishing.

63. The method as defined in claim 62, further comprising the step of firing the electrolyte layer prior to application of the electrode layer.

64. The method as defined in claim 62 wherein the substrate is silicon, and wherein the isolation dielectric is grown on the second side of the substrate.

65. The method as defined in claim 62, further comprising the step of applying a hard mask to the first side of the substrate before the step of creating a well.

66. The method as defined in claim 65 wherein the substrate is silicon, and wherein the first side hard mask is grown on the substrate first side.

67. The method as defined in claim 62, further comprising the step of applying a hard mask to the second side of the substrate before the step of creating a counter well.

68. The method as defined in claim 67 wherein the substrate is silicon, and wherein the second side hard mask is grown on the substrate second side.

69. The method as defined in claim 62 wherein the substrate is silicon, and wherein the etching is performed by an etchant selected from the group consisting of wet anisotropic etchants, plasma anisotropic etchants, and mixtures thereof, thereby forming ultra-smooth surfaces on the well and the counter well.

70. The method as defined in claim 69 wherein the wet anisotropic etchants are selected from the group consisting of potassium hydroxide (KOH), tetramethyl ammonium hydroxide (TMAH), a mixture of potassium hydroxide and isopropyl alcohol, ammonium hydroxide, sodium hydroxide, cerium hydroxide, ethylene diamine pyrocatechol, and mixtures thereof.

71. The method as defined in claim 69 wherein the plasma anisotropic etchant is sulfur hexafluoride alternated with C_4F_8.

72. The method as defined in claim 62 wherein the substrate is a silicon oxide containing dielectric substrate, and wherein the etching is performed by a hydrofluoric containing isotropic etchant.

73. The method as defined in claim 62 wherein the substrate is selected from the group consisting of single crystalline silicon, polycrystalline

silicon, silicon oxide containing dielectric substrates, alumina, sapphire, ceramic, and mixtures thereof.

74. The method as defined in claim 73 wherein the substrate is single crystalline silicon.

75. The method as defined in claim 62 wherein at least one of the well and the counter well is adapted to contain a thick film electrode layer.

76. The method as defined in claim 75 wherein the well contains a thick film electrode and the counter well contains a thick film counter electrode.